Notes of 8/6/03 Meeting with Dave Williamson

Summary

After yesterday's (8/5/03) meeting on outlining/tasking for the planned BAMS paper, today's discussion dealt with:

1) "Show and Tell" results by Shaocheng, Dave, and Jim (see details below)

2) Available figures (some to be modified) for planned BAMS or J. Climate papers

- Slow evolution of cold bias in tropical tropopause vs. fast evolution of split ITCZ (Dave)
- Sensitivity of land spin-up to start time (e.g. January vs. October) in "perfect model" study (Dave)
- Z500 RMS error growth, CAM2 vs. 4 NWP models (Dave--anomaly correlations TBD by Mike--see action items below.)
- Comparison of model humidity vs. large-scale (reanalysis) and obs at SGP to show consistency of CAM2 moisture bias (Jerry, Jay)
- CAM2 precip in April vs. July 1997 to show relatively better results in simulating large-scale vs. convective precip and to motivate Shaocheng's study of different convective schemes (Jim)
- Possible: CAM2 July 1997 precip over China compared with GPCP obs to show better large-scale simulation of precip, e.g. Maiu rain (Jim). Alternative: demonstrate using dynamical tendency in column at ARM SGP site (see action items below)

3) Action items: calculations/figures/tables still to be done for BAMS or J. Climate papers

- Anomaly correlations of CAM2 Z500 forecasts vs. NWP models, and sensitivity to T42 truncation (Mike)
- Comparison of 3-hr accumulated CAM2 precip initialized by nudging vs. forecast-analysis using both ERA40 and R2, showing relatively small differences relative to model biases (Jim)
- 12-36 hr average forecasts of precip for nudged vs. forecast-analysis initialization (Dave)
- Surface fluxes for 4 grid cells (A,B,C,D) that enclose SGP sites vs. corresponding ARM obs to assess degree of regional model/data heterogeneity (Shaocheng?)
- Sensitivity of forecast errors to averaging interval (e.g. 12-36 hour vs. 24-48 hour averaging) and initial time (e.g. 0Z vs. 6Z) (Dave?)
- Mean humidity tendency in atmospheric column for CAM2 vs. ARM SGP obs, with break-out of different budget terms (Jim, Dave)
- Mean temperature tendency in column for CAM2 vs. ARM obs, with break-out of budget terms (Jim, Dave)
- Mean dynamical tendency in column for CAM2 vs. ARM obs, with break-out of budget terms to show better large-scale simulation of precip (Jim, Dave)

- SGP surface moisture and energy budgets: CAM2 vs. ARM obs (Jim, Tom, Jerry)
- Consistent (according to similar soil types) comparison of soil moisture/temperature, CAM2 vs. ARM SWAT data (Jim, Tom)
- Time series of CAM2 vs. radar clouds to show model's scant middle clouds (Jerry, Jay)
- Time series of CAM2 vs. ARM SGP PBL height (to show that model's sfc latent heating doesn't penetrate upward far enough--impacts on middle cloud formation); this should also be manifested by CAM2 diffusive tendency budget (Jim, Dave)
- Time series of CAPE (defined/calculated consistently) for CAM2, ARM, ERA40, and R2 at SGP site (Shaocheng, Jim)
- Table of ARM and other relevant obs for CAPT (Ric)

4) List of planned future (following BAMS and J. Climate) papers

- "Perfect Model" (Dave)
- "Perfect Analysis" (Mike)
- Split ITCZ study (Dave et al.)
- Convection parameterization sensitivity (Shaocheng)

At day's end, we decided to meet again ~ mid-October with Dave to sort through items 2) and 3), so that we can work out the contents of the J. Climate paper in more detail. At that time, we also will critique a first draft of the BAMS paper (Tom).

Details of "Show and Tell" (*with items esp. relevant for BAMS & J. Climate papers italicized*)

Shaocheng: Convective scheme changes

- Showed preliminary results from study of different convective schemes implemented in the model: standard CAM2 (Zhang-McFarlane) convection, G. Zhang's revised convective scheme, and Shaocheng's modified convective trigger. *Results were separately analyzed in 4 CAM2 grid boxes (designated A,B,C,D) that enclose the ARM central and satellite facilities.*
- *Shaocheng's scheme reduces the number of convective precip events and aligns these better with obs, while G. Zhang's scheme seems to damp the convective precip too severely.*
- To do: 12-36 hour ensemble-average forecast statistics for each of the 3 convective schemes (to eliminate spin-up/spin-down effects in precip while including forecasts made before relatively large errors set in) as a prerequisite for further analysis. *Selected results of this study may be shown in BAMS paper, while reserving details for a future paper by Shaocheng.*

Dave: Perfect model, Z500 RMS error growth, CAM2 systematic biases

Perfect Model

- *The spin-up period for the CAM2 land model is greater when the nudging starts in January as opposed to July or October.* By selectively removing snow-covered grid points, it is demonstrated that this sensitivity to spin-up start time is mainly due to January snow cover, which also affects soil moisture (esp. at deeper levels).
- *However, spin-up of the land starting in January 1997 seems to be "good enough" to initialize the CAM2 for the April and July 1997 IOPs*: In April, the soil moisture at the SGP site shows reasonable agreement with ARM obs, while in July there is a fortuitous cancellation of errors, as the positively biased model precipitation offsets a general tendency for the land model to rapidly dry out. (The reason for this excessive drying is currently not understood.)
- However, during July 1997 the diurnal cycle of the model's surface latent heat flux (the real motivation for spinning up the land model) also shows large errors at the SGP site. *These model shortcomings underscore the need to compare the CAM2's column/surface energy and moisture budgets and to address land spin-up more fully in the future.* (Initial attempts to implement P. Viterbo's soil moisture "remapping" in CAM2 also aren't very encouraging, so may eventually need to devise a more involved land spin-up scheme.)

Z500 RMS Error Growth

- *Showed plots of integrated Northern and Southern Hemispere RMS error growth in forecasts of Z500 from CAM2 (for both nudged and forecast-analysis initialization) compared with those of 4 NWP models.* (Mike will produce similar comparisons of anomaly correlations for CAM2 vs. NWP models and investigate the effects of truncating the NWP results at T42.)
- *Results for CAM2 are surprisingly good: no significant evidence of initialization noise, and in some cases, RMS errors are less than for one or more of the NWP models--probably because the Z500 field can be adequately represented at T42 resolution*. (The bias portion of the RMS error that grows faster in CAM2 than in the NWP models, while the total error is not much different.) Also, forecast-analysis ICs are only slightly superior to nudged ICs, and the latter could certainly be improved by experimenting with different nudging coefficients etc.

CAM2 Systematic Biases

- *Showed the time series of forecast minus model climatology, indicating that the cold bias near the CAM2 tropical tropopause sets up slowly, and thus is probably not susceptible to CAPT diagnosis. In contrast, the anomalous split ITCZ is pertinent for CAPT because it sets up within 5 days.* (Dave has examined different manifestations of this phenomenon--in precip, moisture convergence, vertical motion, P-E, etc.)

Jim: CAM2 precip, CAPE, omega, theta-e, soil temperature vs reanalyses/obs

- *Showed many aspects of precip at the SGP site compared with ARM and other obs. Precip time series for multiple forecasts in April 1997 look pretty good (owing to adequate simulation of large-scale precip), but during July 1997 the CAM2 rains out moisture almost every day, in contrast to obs--indication of deficient convection scheme.* Time series of CAPE, vertical motion, theta, theta-e, and theta-e* for CAM2 vs. ERA40 and R2 also indicate model deficiencies of this type.
- Comparison of CAM2 precip in July 1997 with obs over U.S. also show model's characteristically excessive precip east of Rockies (also present in AMIP2 run). (Need to show that this is not an artifact of the interpolation of reanalysis data in mountainous regions.) In contrast, comparison of CAM2 precip over Chinese plains (35N, 110 E) with GPCP obs is fairly good in July 1997, presumably because model does better simulation of large-scale precip (e.g. as in Chinese Maiu).
- *At SGP site in June/July 1997, nudged vs. forecast-analysis initializations yield similar results for precip (but both are wrong, as noted above). Nudging with ERA40 vs. R2 show somewhat greater differences, but precip peaks are contemporaneous (just amplitudes are somewhat different).* (Initialization spin-down effects are more pronounced in the Tropics, e.g. at Nauru site, possibly related to CAM2's anomalous split ITCZ).
- *Comparison of July 1997 CAM2 upper soil temperature vs. ARM SWAT data for multiple points shows model's consistent positive bias. Also need to compare soil moisture by similar soil type. (Dave will get more info of this sort on the land model).*

BAMS Paper outline

1. Introduction: White Paper (WP) Section 1 (**Tom**)
    a. POTENTIALS: they did initial error – nudging term **Mike and Tom**
    b. CAPT: another way to get insights
        i. Field campaigns, hierarchy of models
        ii. Contrast with SCMs fill gap between SCM and Global model
            1. GCMs use an incomplete set – not enough to drive an SCM – example
            2. Feedbacks – no feedback in SCM (Randall 1996 J. Climate paper)
            3. CAPT could be used before implemented into a full climate model
            4. Evaluate parameterization (**Shaocheng**)
            5. Sort things by synoptic category
2. Scientific Rationale for CAPT: WP Section 2
    a. Systematic error in climate and NWP – define – make connection
    b. figure showing error growth and non-error (fast vs. slow) –
        i. **(Dave)** "show and tell": add text to say that compensating errors may occur and need to be removed error in forecast may not appear in climate – but need to be fixed somehow…..may not have an example
    c. Refer to conference on systematic errors (**Tom and Jerry**)
    d. Mention POTENTIALS –
    e. The CAPT Diagnostic Protocol (as applied to CAM2)
    f. Discuss elements of flow diagram (WP Figure 1 and Section 3) – simplified scheme – find Christian's figure, if simpler use it (**Tom and Jerry**)
    g. Examples of available ARM field obs and satellite data DIME (?)(WP Section (**Ric**) useful for GCM testing
3. Initialization methods (WP Section 4.2 expanded) (**Dave and Jim Figure**)
    a. nudging, direct insertion – comparison – interpolation land data assimilation – "good enough" no noise problem nudging vs. forecast analysis examples (**Jim and Dave and Mike**) figure compared with NWP models (RMS, Anomaly correlation)
    b. recalculate scores for NCEP on T42 scale (**Mike**) 500 hts (NCEP as they calculate and NCEP truncated) July 1997
4. Model forecasts (expanded WP Section 4.3, with example figures from 1997 IOP)
    a. example of forecast at SGP site to show consistency with large-scale humidity errors TBD (**Dave, Jerry, and Jim**)--use pictures where we may be able to fix
    b. Precipitation forecasts in 1997 spring vs summer compared with SGP obs to show need for mods to CAM2 convection
    c. Convective activity trigger fix (**Shaocheng**)
5. Conclusions and Summary